Ephemeris of the Satellites of Mars, 1890. By A. Marth.

Greenwich Noon.		P	*Phobos.* a_1	b_1	u_1-U	a_2	*Deimos.* b_2	u_2-U	U	B
1890.		°	″	″	°	″		°	°	°
Apr.	14	33·29	18·45	+1·85	343·23	46·19	+4·65	234·09	210·09	+5·78
	16	33·24	18·86	1·89	80·81	47·19	4·73	84·24	210·29	5·76
	18	33·20	19·27	1·93	178·44	48·21	4·84	294·43	210·45	5·76
	20	33·18	19·68	1·98	276·11	49·25	4·96	144·66	210·57	5·78
	22	33·17	20·10	2·04	13·81	50·30	5·11	354·94	210·64	5·83
	24	33·18	20·52	2·11	111·55	51·36	5·28	205·25	210·67	5·90
	26	33·20	20·95	2·19	209·33	52·43	5·48	55·61	210·66	6·00
	28	33·24	21·38	2·28	307·15	53·50	5·71	266·01	210·61	6·12
	30	33·30	21·80	2·38	45·02	54·56	5·96	116·45	210·51	6·27
May	2	33·37	22·23	+2·49	142·93	55·62	+6·24	326·93	210·37	+6·44
	4	33·46	22·65	2·62	240·87	56·67	6·55	177·46	210·18	6·63
	6	33·56	23·06	2·76	338·85	57·71	6·89	28·03	209·95	6·85
	8	33·68	23·46	2·90	76·88	58·72	7·26	238·65	209·67	7·10
	10	33·81	23·85	3·06	174·95	59·70	7·66	89·31	209·36	7·37
	12	33·96	24·23	3·23	273·05	60·64	8·08	300·00	209·00	7·66
	14	34·12	24·59	3·41	11·19	61·54	8·53	150·74	208·60	7·97
	16	34·29	24·93	3·60	109·36	62·39	9·00	1·51	208·17	8·30
	18	34·47	25·25	3·80	207·56	63·18	9·49	212·31	207·70	8·64
	20	34·65	25·54	4·00	305·79	63·90	10·00	63·14	207·20	9·00
	22	34·84	25·80	4·20	44·04	64·55	10·52	274·00	206·68	9·38
	24	35·03	26·03	4·41	142·30	65·13	11·04	124·88	206·13	9·76
	26	35·22	26·22	4·62	240·58	65·62	11·56	335·78	205·56	10·14
	28	35·41	26·38	4·82	338·86	66·02	12·07	186·69	204·98	10·53
	30	35·60	26·51	5·02	77·15	66·33	12·57	37·60	204·40	10·92
June	1	35·78	26·60	+5·21	175·44	66·55	+13·05	248·51	203·81	+11·31
	3	35·95	26·65	5·40	273·72	66·68	13·51	99·42	203·23	11·69
	5	36·12	26·66	5·57	11·98	66·72	13·94	310·32	202·65	12·06
	7	36·28	26·64	5·73	110·23	66·67	14·33	161·21	202·09	12·42
	9	36·43	26·58	5·87	208·45	66·53	14·69	12·07	201·55	12·76
	11	36·57	26·49	6·00	306·65	66·30	15·01	222·91	201·03	13·09
	13	36·69	26·37	6·11	44·82	65·99	15·29	73·72	200·54	13·39
	15	36·81	26·21	6·20	142·94	65·60	15·52	284·50	200·08	13·68
	17	36·91	26·03	6·27	241·03	65·14	15·70	135·24	199·66	13·95
	19	37·00	25·82	6·33	339·07	64·62	15·84	345·94	199·28	14·19
	21	37·08	25·59	6·36	77·07	64·04	15·93	196·59	198·94	14·40

Greenwich Noon. 1890.		P	*Phobos.* a_1	b_1	u_1-U	*Deimos.* a_2	b_2	u_2-U	U	B
		°	"	"	°	"	"	°	°	°
June	23	37·15	25·34	+ 6·38	175·02	63·41	+ 15·97	47·19	198·65	+ 14·
	25	37·21	25·07	6·38	272·91	62·74	15·97	257·75	198·41	14·
	27	37·25	24·79	6·37	10·75	62·03	15·93	108·26	198·22	14·
	29	37·29	24·49	6·34	108·54	61·28	15·85	318·71	198·08	14·
July	1	37·32	24·18	+ 6·29	206·28	60·51	+ 15·74	169·12	197·99	+ 15·
	3	37·33	23·86	6·23	303·96	59·72	15·59	19·47	197·95	15·
	5	37·34	23·54	6·16	41·59	58·91	15·40	229·77	197·96	15·
	7	37·34	23·21	6·07	139·17	58·09	15·19	80·02	198·02	15·
	9	37·32	22·88	5·97	236·70	57·27	14·95	290·22	198·13	15·
	11	37·30	22·55	5·87	334·17	56·44	14·69	140·37	198·29	15·
	13	37·27	22·22	5·76	71·59	55·61	14·41	350·47	198·50	15·
	15	37·23	21·89	5·64	168·97	54·78	14·10	200·53	198·76	14·
	17	37·18	21·56	+ 5·51	266·30	53·95	+ 13·78	50·54	199·06	+ 14·
	19	37·11	21·23	5·37	3·58	53·13	13·44	260·50	199·40	14·6
	21	37·03	20·91	5·23	100·82	52·32	13·09	110·42	199·79	14·4
	23	36·95	20·59	5·09	198·02	51·52	12·73	320·30	200·22	14·3
	25	36·86	20·27	4·94	295·18	50·73	12·35	170·14	200·69	14·1
	27	36·75	19·96	4·78	32·29	49·95	11·97	19·94	201·20	13·8
	29	36·63	19·66	4·63	129·37	49·19	11·58	229·70	201·74	13·6
	31	36·49	19·36	4·47	226·42	48·45	11·19	79·43	202·32	13·3
Aug.	2	36·34	19·07	+ 4·31	323·43	47·71	+ 10·79	288·13	202·93	+ 13·0
	4	36·18	18·78	4·15	60·40	46·99	10·39	138·79	203·58	12·7
	6	36·01	18·50	3·99	157·35	46·29	9·98	348·42	203·25	12·4
	8	35·82	18·22	3·82	254·27	45·60	9·57	198·03	204·95	12·1
	10	35·61	17·95	3·66	351·16	44·92	9·16	47·61	205·68	11·7
	12	35·39	17·69	3·49	88·02	44·26	8·74	257·16	206·44	11·3
	14	35·15	17·43	3·33	184·86	43·61	8·33	106·69	207·22	11·0
	16	34·90	17·18	+ 3·16	281·67	42·98	+ 7·91	316·19	208·02	+ 10·6

In this ephemeris the two satellites are assumed to move in a plane, the node N and inclination J of which, in reference to the plane parallel to the Earth's equator, are :—

$$N = 49°·563\,; \quad J = 36°·021.$$

The assumed orbital longitudes, reckoned from the node, are :—

$$\text{Phobos } u_1 = 22°·41 + 1128°·8445\,(t - t_0)$$
$$\text{Deimos } u_2 = 93·12 + 285·1622\,(t - t_0)$$

the epoch t_0 being 1890, June, 1·0 Gr.

The values of P, a, b, $u-U$ are to be interpolated directly for the times for which the positions of the satellites are required, and the position-angles p and distances s are then found by means of the formulæ:—

$$s \sin (p-P) = a \sin (u-U)$$
$$s \cos (p-P) = b \cos (u-U).$$

Greenwich times, at which the satellites will be at their greatest elongations (e in position P+90° and w in position P−90°), the designation, in the case of *Phobos*, belonging to both given times, so that an elongation on the opposite side occurs at mid-time between them:—

1890.	*Phobos.* h		h	*Deimos.* h	1890.	*Phobos.* h		h	*Deimos.* h
Apr. 14	17·6	*e*	25·2	18·2 *e*	May 12	11·4	*e*	19·1	12·6 *e*
15	16·5	*e*	24·2	24·5 *e*	13	14·2	*w*	21·8	18·9 *e*
16	15·5	*e*	23·2	15·6 *w*	14	13·2	*w*	20·8	10·0 *w*
17	14·5	*e*	22·1	21·9 *w*	15	12·1	*w*	19·8	16·3 *w*
18	13·4	*e*	21·1	13·1 *e*	16	11·1	*w*	18·7	22·6 *w*
19	12·4	*e*	20·0	19·4 *e*	17	13·8	*e*	21·5	13·7 *e*
20	15·2	*w*	22·8	25·7 *e*	18	12·8	*e*	20·5	20·0 *e*
21	14·1	*w*	21·8	16·8 *w*	19	11·8	*e*	19·4	11·1 *w*
22	13·1	*w*	20·8	23·1 *w*	20	10·7	*e*	18·4	17·4 *w*
23	15·9	*e*	23·5	14·3 *e*	21	13·5	*w*	21·1	23·7 *w*
24	14·9	*e*	22·5	20·6 *e*	22	12·5	*w*	20·1	15·3 *e*
25	13·8	*e*	21·5	11·7 *w*	23	11·4	*w*	19·1	21·1 *e*
26	12·8	*e*	20·4	18·0 *w*	24	10·4	*w*	18·0	12·2 *w*
27	11·7	*e*	19·4	24·3 *w*	25	13·1	*e*	20·8	18·5 *w*
28	14·5	*w*	22·2	15·5 *e*	26	12·1	*e*	19·7	9·6 *e*
29	13·5	*w*	21·1	21·8 *e*	27	11·1	*e*	18·7	15·9 *e*
30	12·4	*w*	20·1	12·9 *w*	28	10·0	*e*	17·7	22·1 *e*
May 1	15·2	*e*	22·9	19·2 *w*	29	12·8	*w*	20·4	13·3 *w*
2	14·2	*e*	21·8	10·3 *e*	30	11·7	*w*	19·4	19·5 *w*
3	13·1	*e*	20·8	16·6 *e*	31	10·7	*w*	18·4	10·7 *e*
4	12·1	*e*	19·7	22·9 *e*	June 1	9·7	*w*	17·3	16·9 *e*
5	14·9	*w*	22·5	14·1 *w*	2	12·4	*e*	20·1	8·1 *w*
6	13·8	*w*	21·5	20·3 *w*	3	11·4	*e*	19·0	14·3 *w*
7	12·8	*w*	20·4	11·5 *e*	4	10·3	*e*	18·0	20·6 *w*
8	11·7	*w*	19·4	17·8 *e*	5	9·3	*e*	17·0	11·7 *e*
9	14·5	*e*	22·2	8·9 *w*	6	12·1	*w*	19·7	18·0 *e*
10	13·5	*e*	21·1	15·2 *w*	7	11·0	*w*	18·7	9·1 *w*
11	12·4	*e*	20·1	21·5 *w*	8	10·0	*w*	17·6	15·4 *w*

1890.	*Phobos.* h		*Deimos.* h	1890.	*Phobos.* h		*Deimos.* h
June 9	12·8	*e* 20·4	21·7 *w*	July 11	10·1	*e* 17·8	10·9 *w*
10	11·7	*e* 19·4	12·8 *e*	12	9·1	*e* 16·7	17·2 *w*
11	10·7	*e* 18·3	19·1 *e*	13	8·0	*e* 15·7	8·4 *e*
12	9·6	*e* 17·3	10·2 *w*	14	10·8	*w* 18·5	14·7 *e*
13	12·4	*w* 20·1	16·5 *w*	15	9·8	*w* 17·5	5·8 *w*
14	11·4	*w* 19·0	7·6 *e*	16	8·8	*w* 16·4	12·2 *w*
15	10·4	*w* 18·0	13·9 *e*	17	11·6	*e* 19·2	18·5 *w*
16	9·3	*w* 17·0	20·2 *e*	18	10·5	*e* 18·2	9·6 *e*
17	8·3	*w* 15·9	11·3 *w*	19	9·5	*e* 17·1	16·0 *e*
18	11·1	*e* 18·7	17·6 *w*	20	8·5	*e* 16·1	7·1 *w*
19	10·0	*e* 17·7	8·7 *e*	21	7·4	*e* 15·1	13·4 *w*
20	9·0	*e* 16·6	15·0 *e*	22	10·2	*w* 17·9	19·8 *w*
21	11·7	*w* 19·4	21·3 *e*	23	9·2	*w* 16·8	10·9 *e*
22	10·7	*w* 18·4	12·5 *w*	24	8·1	*w* 15·8	17·2 *e*
23	9·7	*w* 17·3	18·7 *w*	25	7·1	*w* 14·8	8·4 *w*
24	8·6	*w* 16·3	9·9 *e*	26	9·9	*e* 17·6	14·7 *w*
25	11·4	*e* 19·1	16·2 *e*	27	8·9	*e* 16·5	5·9 *e*
26	10·4	*e* 18·0	7·3 *w*	28	7·8	*e* 15·5	12·2 *e*
27	9·3	*e* 17·0	13·6 *w*	29	10·6	*w* 18·3	18·6 *e*
28	8·3	*e* 15·9	19·9 *w*	30	9·6	*w* 17·3	9·7 *w*
29	11·1	*w* 18·7	11·0 *e*	31	8·6	*w* 16·2	16·1 *w*
30	10·0	*w* 17·7	17·3 *e*	Aug. 1	7·5	*w* 15·2	7·2 *e*
July 1	9·0	*w* 16·7	8·5 *w*	2	10·3	*e* 18·0	13·6 *e*
2	8·0	*w* 15·6	14·8 *w*	3	9·3	*e* 17·0	19·9 *e*
3	10·8	*e* 18·4	5·9 *e*	4	8·3	*e* 15·9	11·1 *w*
4	9·7	*e* 17·4	12·2 *e*	5	7·3	*e* 14·9	17·4 *w*
5	8·7	*e* 16·3	18·5 *e*	6	10·0	*w* 17·7	8·6 *e*
6	11·5	*w* 19·1	9·7 *w*	7	9·0	*w* 16·7	14·9 *e*
7	10·4	*w* 18·1	16·0 *w*	8	8·0	*w* 15·6	6·1 *w*
8	9·4	*w* 17·0	7·1 *e*	9	7·0	*w* 14·6	12·4 *w*
9	8·4	*w* 16·0	13·4 *e*	10	9·8	*e* 17·4	18·7 *w*
10	11·2	*e* 18·8	19·8 *e*	11	8·7	*e* 16·4	9·9 *e*

If the assumed plane of the orbits does not differ too much from their true planes, this year's cycle of eclipses of *Phobos* will last from about March 19 to October 9, that of *Deimos* from June 2 to August 9, the central eclipses occurring about July 7. The earliest eclipses of *Deimos* will not be observable, but a week after the beginning of the cycle the satellite will be at its disappearance more than half a semi-diameter of the planet's disc outside the disc. In order to induce observers to watch duly for the disappearances and reappearances of the satellite, I give

approximate Greenwich times of the middle of the eclipses and of their semi-duration, it being understood that these predictions may be sensibly in error. It will be of special importance to observe the latest eclipses of the cycle, the duration of which is very uncertain.

Eclipses of Deimos.

	Middle.	Semi-dur.		Middle.	Semi-dur.		Middle.	Semi-dur.
	h m	m		h m	m		h m	m
June 8	23 47	24	June 30	11 47	40	July 24	12 31	35
11	12 29	27	July 1	18 8	42	25	18 53	34
12	18 50	29	5	13 12	4	28	7 36	31
15	7 32	32	6	19 33	4	29	13 57	30
16	13 54	33	9	8 16	42	30	20 19	28
17	20 15	34	10	14 37	4	Aug. 2	9 1	24
20	8 57	36	11	20 58	4	3	15 23	22
21	15 18	37	14	9 41	40	7	10 27	? 12
22	21 39	38	15	16 2	40	8	16 49	? 8
25	10 22	39	19	11 6	38	12	11 54	?
26	16 43	39	20	17 27	38	13	18 15	?

The disappearances of *Phobos* into the planet's shadow will not be observable, and I give therefore approximate Greenwich times of its reappearances, the error of which, though it may be very sensible, will probably not vary much.

Eclipses of Phobos. Reappearances.

	h m	h m		h m	h m		h m	h m
June 15	13 0	20 39	July 5	7 46	15 26	July 25	10 11	17 51
16	11 58	19 38	6	14 24	22 4	26	9 10	16 49
17	10 57	18 36	7	13 22	21 2	27	8 8	15 48
18	9 55	17 34	8	12 21	20 0	28	7 6	14 46
19	8 43	16 23	9	11 19	18 58	29	6 4	13 44
20	15 31	23 10	10	10 18	17 57	30	5 3	12 42
21	14 29	22 9	11	9 16	16 55	31	11 40	19 20
22	13 27	21 7	12	8 14	15 54	Aug. 1	10 38	18 18
23	12 26	20 5	13	7 12	14 52	2	9 37	17 16
24	11 24	19 4	14	6 10	13 50	3	8 35	16 15
25	10 23	18 2	15	12 48	20 28	4	7 34	15 13
26	9 22	17 1	16	11 47	19 26	5	6 32	14 11
27	8 21	16 0	17	10 45	18 25	6	5 30	13 9
28	7 19	14 58	18	9 44	17 23	7	12 8	19 47
29	14 6	21 36	19	8 42	16 21	8	11 6	18 46
30	12 55	20 34	20	7 40	15 20	9	10 5	17 44
July 1	11 53	19 32	21	6 38	14 18	10	9 3	16 42
2	10 51	18 30	22	5 37	13 16	11	8 1	15 40
3	9 50	17 29	23	12 15	19 54	12	7 0	14 39
4	8 48	16 28	24	11 13	18 52	13	5 58	13 37

During the period for which these ephemerides of the satellites are given, the light-ratio (to be found in the preceding ephemeris for physical observations of the planet) is at least one half of that at mean opposition. It would not be worth the trouble to extend micrometrical measurements beyond or even up to the limits of this period. But, as it would be of essential service for the determination of the true planes of the orbits (and thereby for the future determination of the ellipticity of the planet) if observations of some of the earliest and latest eclipses of all cycles, which render such observations feasible, were secured, I venture to give the necessary predictions for the earliest eclipses of *Phobos*, though the light-ratio is only about a quarter of that at mean opposition, and though it is doubtful whether the apparent nearness of the satellite to the limb of the planet at its reappearances from the shadow will not prevent its being seen. The oppositions of *Phobos* to the Sun occur about the following Greenwich times:—

	h m	h m		h m	h m		h m	h m
Mar. 16	14 20	21 59	Mar. 20	17 52	25 31	Mar. 24	13 45	21 24
17	13 18	20 57	21	16 50	24 29	25	20 22	...
18	12 16	19 56	22	15 48	23 27	26	19 21	...
19	18 54	...	23	14 46	22 25	27	18 19	25 58

About $1^{h}\cdot2$ before these times *Phobos* will be at its apparent greatest western elongations. But the apparent positions of both satellites may be found with the help of the following ephemeris, in which the values a, b of the semi-axes of the apparent ellipses are expressed, not in seconds of arc, but in semi-diameters of the planet's disc.

		Phobos.			*Deimos.*		
Greenwich Noon.	P	a_1	b_1	u_1-U	a_2	b_2	u_2-U
	°	″	″	°	″	″	°
Mar. 17	35·06	2·765	+0·391	60·35	6·920	+0·980	175·55
19	34·90		·379	157·55		·949	25·28
21	34·75		·368	254·76		·920	235·04
23	34·60		·357	351·99		·892	84·82
25	34·45	2·765	+0·346	89·25	6·920	+0·866	294·62

If observers will be good enough to publish or communicate in time the results of their endeavours to observe the first eclipses of *Phobos*, I intend to give the prediction for the rest of the cycle, in case that appears desirable.